Addendum: 2012 Statewide Perspective on the Health of Maine Lakes

The following information is derived from summary data for several hundred lakes throughout Maine in 2012. The data sources are the Maine Volunteer Lake Monitoring Program and Maine DEP. Several of the illustrations were developed by the Maine Volunteer Lake Monitoring Program, in collaboration with the Maine DEP. Narrative interpretation of the information was prepared by Scott Williams.

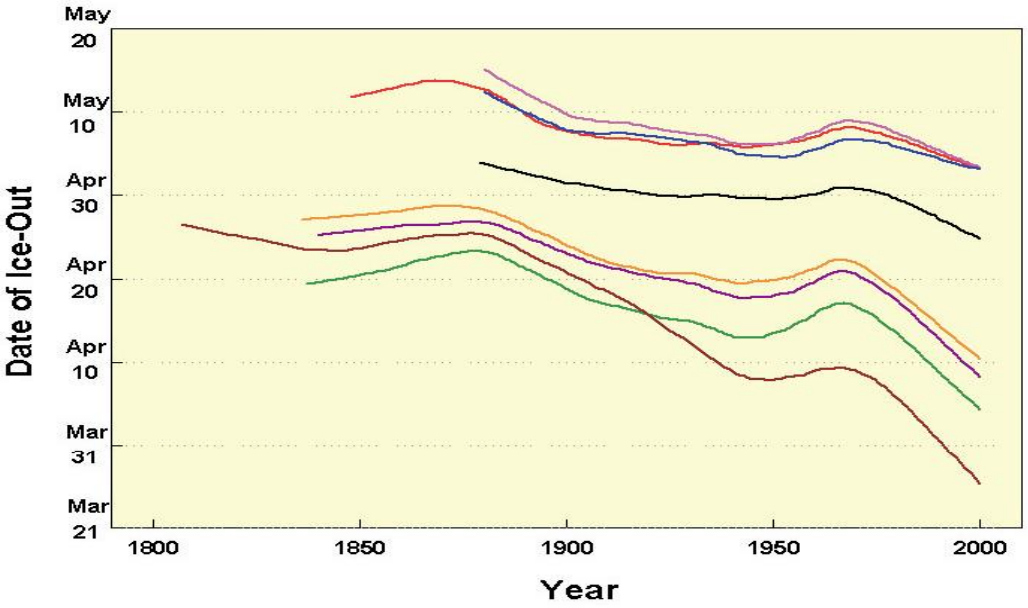
2012 Weather Influences on Maine Lakes

Maine weather during the winter, spring and summer of 2012 was unusual, and could be characterized as "extreme". Precipitation during the winter and spring throughout much of Maine was light, resulting in a lower than normal snowpack and spring runoff. The weather was also abnormally warm throughout much of the winter, and especially in March, when air temperatures exceeded 80 degrees F. in southern and central areas of the state. Lake ice melted rapidly, and most lakes throughout Maine were free of ice from 3-4 weeks earlier than their historical average. National Weather Service records indicate that Portland experienced the 2nd warmest April in 72 years, and May was the 9th consecutive month during which the temperature was above normal. While June temperatures were closer to normal, July 2012 was the warmest (July) on record, and Portland experienced the 5th warmest August in 72 years. Precipitation was above normal in May, June, July and August.

The early loss of ice cover, combined with very warm air temperatures caused thermal stratification of lakes throughout Maine to occur earlier than normal in the spring. On June 3 an intense rain event occurred, during which areas of southern and central Maine received from 6 to 8 several inches of precipitation in just over 24 hours. Many volunteer monitors reported observations of severe soil erosion from stormwater runoff in their lake watersheds, often resulting in dramatic drops in Secchi transparency. For example, early season Secchi readings on Thompson Lake in Oxford were in the 9 meter range, but following the June storm, the Secchi reading dropped to 5.3 meters. Similarly, in Lake Auburn, only a few days before the storm, the Secchi reading was 7.3 meters, but water clarity dropped to 5.6 meters following the storm. Continued abnormally warm weather resulted in lake surface temperatures in southern and central Maine reaching, and in some cases exceeing 80 degrees F. by the end of June. (excerpted from the 2012 Maine Lakes Report , Maine Volunteer Lake Monitoring Program; Scott Williams)

During the past decade, a great deal of discussion has taken place among lake scientists throughout the world concerning possible effects that climate change may have on lakes. Lake systems are highly sensitive to weather fluctuations, as we have observed in the long history of annual water quality data for many Maine lakes. Nearly all of the models for global climate change suggest that, in addition to warming trends we will likely experience increasingly extreme weather events in the future. Indeed, there have within the past several years been a number of such events that have gained national attention. In fact, a number of examples of such weather occurred here in Maine last summer, including record-breaking early ice out for lakes throughout Maine in March, record high air temperatures in the spring and summer, a severe 48

hour storm in early June, in which nearly 8 inches of rain fell in southwestern Maine, and record breaking lake surface temperatures in June and July.



Smoothed-Line Ice-Out Dates for 8 New England Lakes:
This chart illustrates the progressively earlier ice-out dates on 8 New England lakes during the past 150 years. (From Hodgkins, James and Huntington, 2005)

While we are just beginning to understand the impact that the 2012 weather had on Maine lakes, a few dramatic examples have been documented. Several lakes that did not have a history of water quality problems experienced severe algal blooms last summer, including Lake Auburn. The Lake Auburn bloom caused what has historically been a clear, clean lake, with low concentrations of phosphorus and algae, and which has supported a highly valued cold water fishery (Lake Trout and Salmon), to turn green for several weeks. The algae bloom and other factors caused dissolved oxygen levels in the lake to plummet in August and September, which resulted in a highly-publicized "fish kill", in which the entire Lake Trout population may have perished over a period of several days. There appear to have been a number of influences that pushed Lake Auburn "over the edge" in 2012, but what seems to have been the trigger was the early loss of winter ice, combined with rapid warming of the lake water in the spring. The 8 inch rain event was likely a factor, as well, causing extensive erosion of phosphorus-rich soil from the watershed to the lake. We are continuing to investigate what happened in Lake Auburn, and in a few other smaller lakes Maine lakes last summer. But there can be little doubt at this point that climate influences were a driving force.

The combined influence of these unusual conditions resulted in below average water clarity, an extended period of thermal stratification, higher than normal dissolved oxygen loss, and a measureable increase in algae growth for some Maine lakes in 2012 – all of which can be characterized as stressful to lake systems.

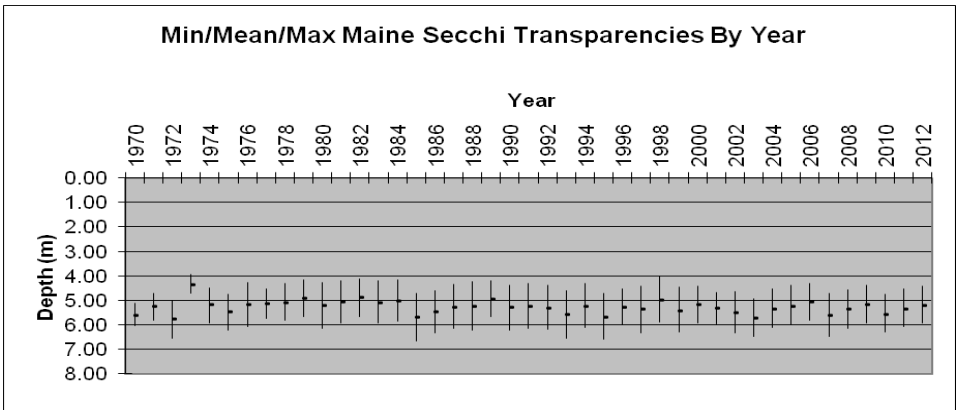
About half (49.6%) of the 415 lakes monitored throughout Maine in 2012 were less clear than they have been historically, and the other half were either clearer (39.5%), or unchanged (10.8%), as illustrated in the pie chart below, produced by the Maine Volunteer Lake Monitoring Program and Maine Department of Environmental Protection. Rain and snow produce stormwater runoff, which is the primary means by which phosphorus and other pollutants are carried into lakes from their watersheds. One might expect that for years when excess precipitation has occurred during the spring and summer period, lakes with developed watersheds might be less clear. Although that is often the case, each lake responds uniquely to the many factors that influence water quality.

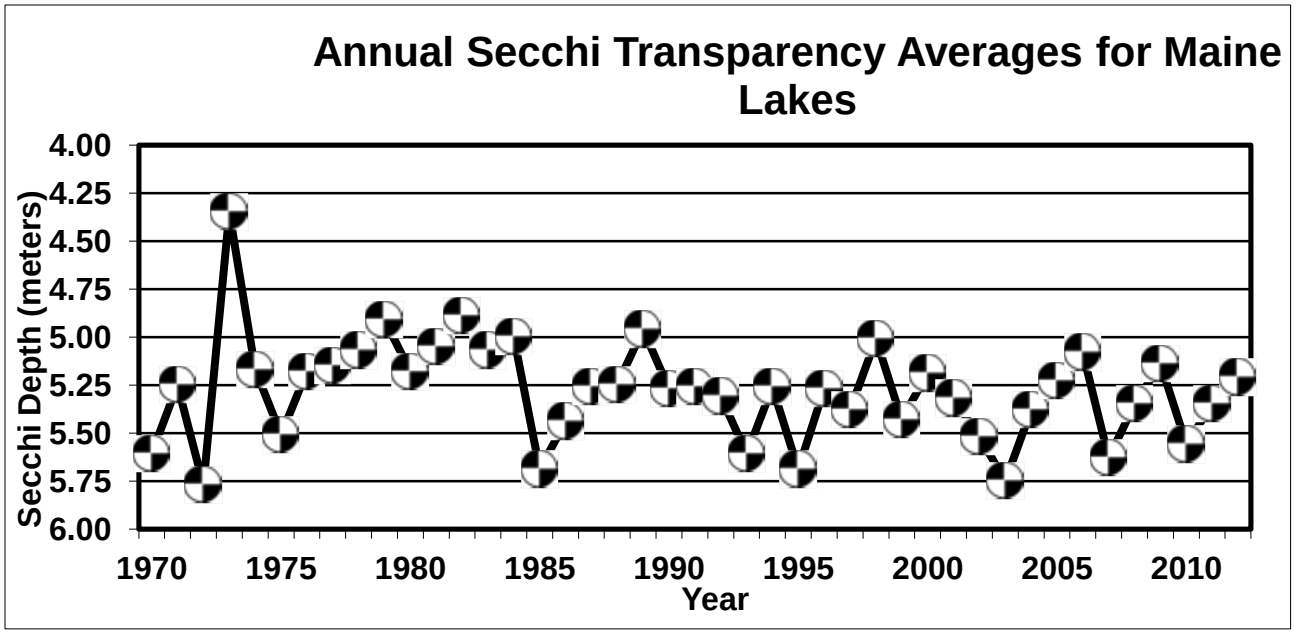
Statewide Perspective on Lake Water Clarity in 2012:

The charts below illustrate the extent to which water clarity (Secchi transparency) has varied for Maine lakes over time. The first shows the average water clarity for all Maine lakes monitored in a given year – denoted by the dot on each annual line of the graph. The average of the highest and lowest readings for each year are indicated by the high and low limits of each annual line. Note that the average has, for most years since this information has been tracked, fallen between 5.0-5.5 meters. The average in 2012 was 5.21 meters. The next figure illustrates only the annual average for Maine lakes, using a Secchi disk symbol.

Variation from one year to the next is influenced by many factors, not the least of which is weather. Maine lakes may be clearer overall during relatively dry years because stormwater runoff from rainfall carries phosphorus and other pollutants from the watershed to the lake.

Source Maine DEP and Volunteer Lake Monitoring Program



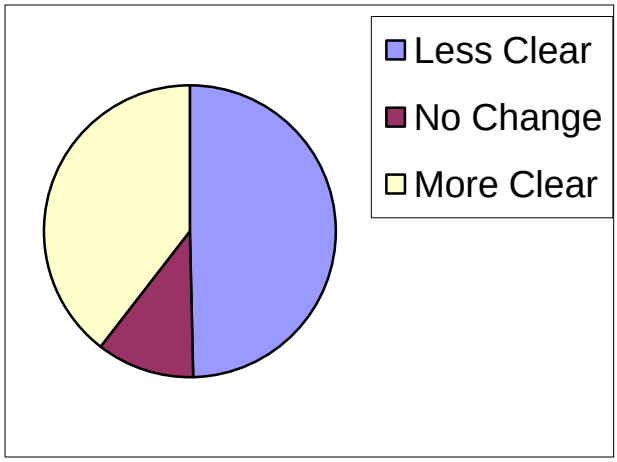


Average Secchi disk transparency (meters) for all Maine lakes monitored for the years shown (MVLMP)

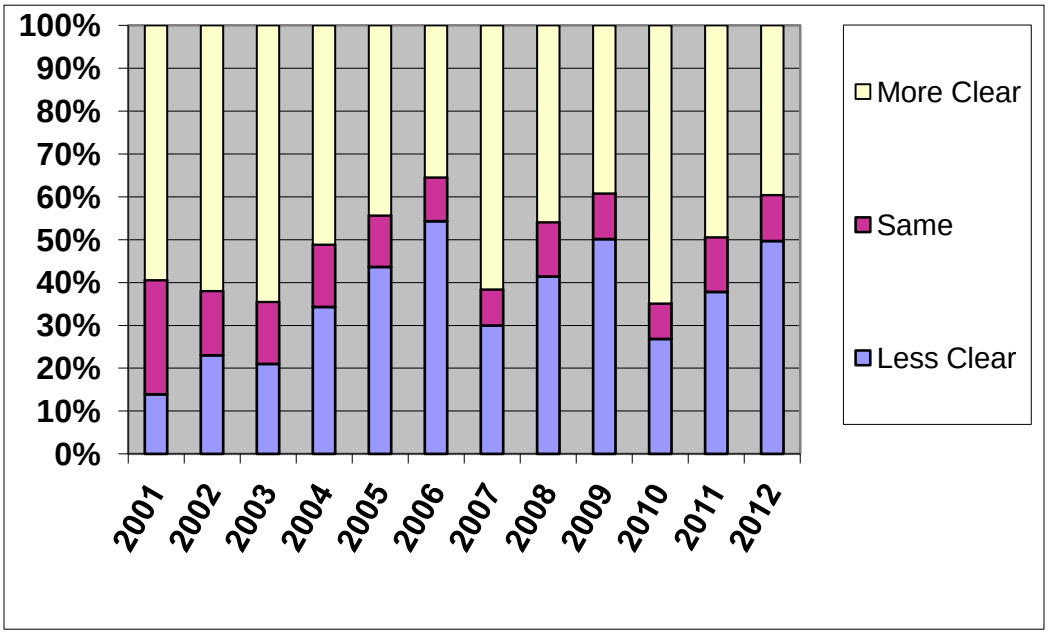
The two illustrations above show that for the period from 2004-2006, the "average" clarity of Maine lakes dropped substantially. This may have been due to the fact that much of the state experienced above average precipitation during the period. But in 2007, Maine lakes as a whole were significantly clearer, most probably due to reduced precipitation during the winter, spring and early summer months, when a high percentage of watershed phosphorus loading typically occurs for lakes. Maine experienced very wet conditions in 2008 and 2009 (which was one the wettest years on record for the state), during which time the average declined, as is indicated. But in 2010, this decline reversed, as the average for Maine lakes increased to 5.6 meters. The statewide minimum for 2010 wasn't as low as it has been for many previous years, which is also consistent with improved conditions for many Maine lakes that year. In 2011 and 2012 the overall average water clarity for Maine lakes declined.

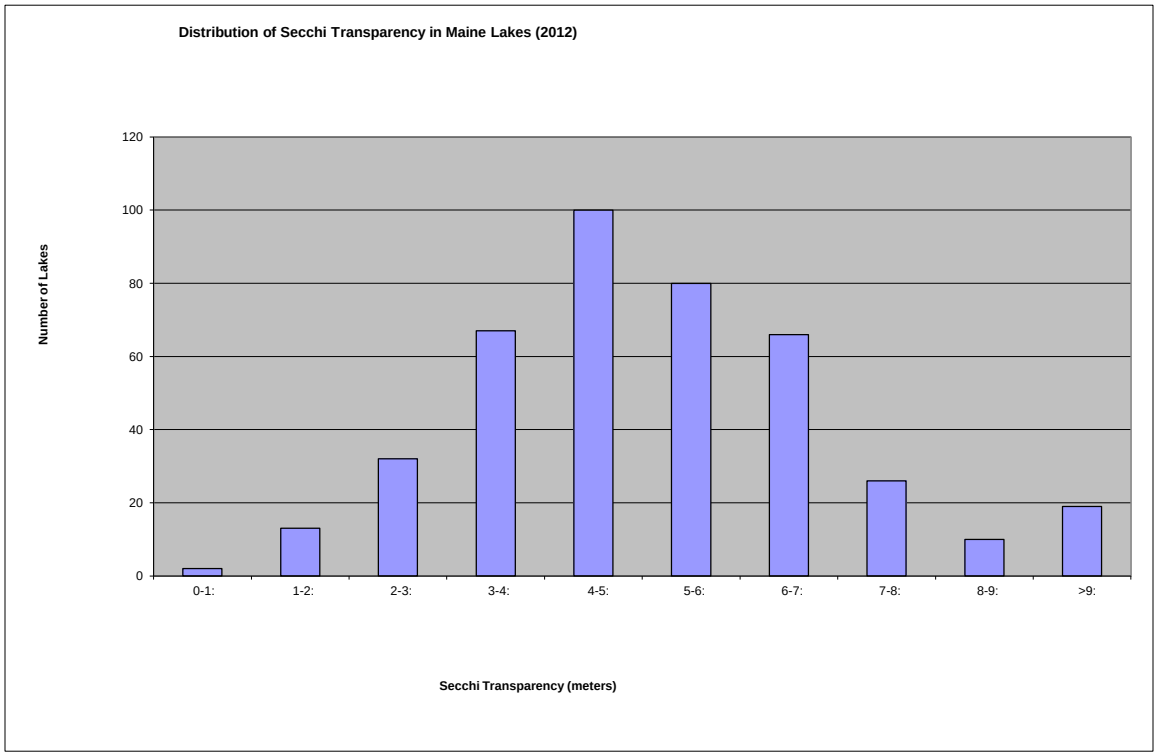
The graphics illustrate some of the dramatic annual shifts have occurred historically. Some of the "clearest" years for Maine lakes have been those during which drought has recently occurred, such as 1985 and 2002 and 2003, which followed the severe statewide drought of 2001. The winter of 2012 will long be remembered as highly unusual, in that winter produced relatively little snow accumulation, abnormally warm spring weather, record-breaking early ice out conditions in lakes throughout Maine, and an extreme rain event in the southerly part of the state in June.

To put into perspective the significance of the 2012 lake clarity findings, consider that out of 415 Maine lakes that were assessed last year, 49.6% were clearer, only 39.5 % were less clear, and 10.8% were unchanged, compared to their historical average (Adjacent Chart: Source Maine VLMP and DEP).



A smaller percentage of Maine lakes were clearer than their historical average in 2012 and 2011, compared to 2010.. The adjacent chart illustrates this interesting phenomenon during the past decade. For most years, it has been possible to generally correlate changes in the number of lakes that were clear or less clear than they have been historically to dominant weather during the several months of the year before and during the monitoring season.





The bars in the chart above show the number of lakes in 2012 whose annual Secchi transparency (water clarity) were within the range of the individual bars. The numbers at the bottoms of the bars from left to right are: 0-1 meter; 1-2 meters; 2-3 meters; 3-4 meters; 4-5 meters; 5-6 meters; 6-7 meters; 7-8 meters; 8-9 meters, and greater than 9 meters

The chart above illustrates the distribution of Secchi transparency (water clarity) for 415 lakes assessed in Maine in 2012, based on individual lake averages. The greatest number of lakes in this group were within the 3-7 meter ranges (bars 3-4; 4-5; 5-6; 6-7 combined). Lakes in the 0-2 meter range experienced severe algal blooms at some point during the monitoring season, and those above 7 meters would be considered to be significantly "above average" for Maine lakes.

Each lake and pond responds in a unique way to the influences of weather, changes in land use in the watershed, and other forces upon the ecosystem. This is because of the wide range of physical, chemical and biological characteristics of each lake basin and its watershed. Most lakes and ponds experience a moderate amount of both seasonal and annual natural variability.

Water clarity (Secchi transparency) is one of three primary indicators of the biological productivity of lake ecosystems, in addition to concentrations of the nutrient phosphorus, and chlorophyll a (a plant pigment used to measure of the concentration of algae in lake water). Another indirect indicator of lake productivity is the concentration of dissolved oxygen in deep areas of the lake during the summer months.